

Melilotus alba*; *Melilotus officinalis
sweetclover or white sweetclover; yellow sweetclover
Fabaceae

Melilotus spp. are monocarpic, annual or biennial herbs of the legume family (Fabaceae), sweet-scented, with alternate, pinnately-thrae-foliate leaves. The flowers are perfect and much like those of *Trifolium* and *Medicago*, but in small, slender spike-like racemes with a deciduous corolla, free from the filaments. The legume is ovoid, leathery and wrinkled, longer than the calyx, and scarcely dehiscent, with one or two seeds (Fernald 1950, Rydberg 1971).

M. alba (also known as *M. albus*) has an erect, branched, glabrous or glabrate stem, 1-3 m high, with serrated, narrowly obovate to oblong leaflets that are truncate or emarginate. It is the only white-flowered sweetclover in the Midwest and Great Plains. The corolla is 4-5 mm long; the fruit is 3-4 mm long and somewhat reticulate (Fernald 1950, Rydberg 1971).

M. officinalis is similar in height and appearance to *M. alba*, the distinguishing feature being the two yellow corolla. The leaflets are closely serrate, obovate-oblong and obtuse. The corolla is 5-6 mm long; the fruit, 2.5-3.5 mm long, glabrous or glabrate and prominently reticulate (Fernald 1950, Rydberg 1971).

Yellow-flowered *M. altissima* and *M. indica* can usually be told from *M. officinalis* by their height and distribution. *M. altissima* is found from British Columbia to Nova Scotia, is very tall (1.6 m) and can be distinguished from *M. officinalis* by its pubescent ovaries and pods.

M. indica is abundant in the South and Pacific states and grows to just 0.5 m. Its flowers are smaller and more densely packed in the raceme than those of *M. officinalis* (Turkington et al. 1978). Sweetclover seedlings closely resemble those of alfalfa (*Medicago* spp.). *Melilotus* may be distinguished from alfalfa by the absence of pubescence on the underside of the leaves and by its bitter taste (Coe 1917). Anna Kummer's *Weed Seedlings* (1951, University of Chicago Press) may be helpful in distinguishing *Melilotus* seedlings from those of other similar legumes.

Melilotus spp. are native to the Mediterranean area through central Europe to Tibet. They were reported in North America as early as 1664 and have been extensively used by agriculturalists as forage crops, soil builders, and as a nectar source for honey bees (Turkington et al. 1978). The sweetclovers have spread from cultivation and thrive in waste places and roadsides throughout the U.S. and Canada.

Both *M. alba* and *M. officinalis* are adapted to a wide range of climatic conditions. They have long taproots and are drought tolerant and winter hardy, but cannot withstand prolonged flooding. *M. alba* is somewhat more tolerant to standing water than *M. officinalis* and is occasionally found on gravelly, open river banks subject to periodic flooding (Turkington et al. 1978). Sweetclovers are found most commonly on calcareous soils and grow best on rich loams and clay loams with pH levels of 6.5 or higher (Turkington et al. 1978, Martin and Leonard 1949). *M. officinalis* is apparently more salt tolerant than *M. alba* (Turkington et al. 1978), although both species will grow on highly alkaline soils (Martin and Leonard 1949).

Both species flower in June and July, *M. officinalis* usually preceding *M. alba* by a few weeks. Unlike some other "biennials", which respond to high densities by delaying reproduction, *M. alba* is an obligate biennial and always flowers and dies in the second year of growth (Klemow and Raynal 1981). *M. officinalis* is probably also obligately biennial.

The following information on *M. alba* comes from Klemow and Raynal (1981). In the first season of growth plants produce a vegetative shoot which typically grows to 10-30 cm by October. Most root development occurs in late summer, after crown growth has slowed. While the roots develop, crown buds begin to form in the axils of the cotyledons and around the crown just below or at the soil surface. The shoot dies back in autumn, and the taproot and

crown bud overwinter. The following spring and early summer, one or more flowering shoots emerge from the buds and rapidly elongate, often attaining a height of 100 cm by August.

Honey bees are the most important pollinators of both species, although the flowers are visited by a number of other bees and insects as well. *M. alba* is attractive to a wider array of insects, including many wasps and flies. Barcikowska (1966) reported white sweetclover to exhibit high self-fertility as well as cross fertility, and yellow sweetclover to have very little incidence of self fertility.

Rainwater runoff and stream flow are probably the most important means of seed dispersal, although wind can blow seeds up to several meters (Turkington et al. 1978). Newly mature seeds will be soft, but as they dehydrate they become temporarily "hard" or impermeable, and can remain viable in this state for many years. Stoa (1941, in Turkington et al. 1978) stated that hard sweetclover seeds could remain viable in the soil for over 20 years. Factors that effect the scarification and germination of hard seeds in nature have not been reported in the literature. Given sufficient moisture, most germination and seedling development occurs from late March through April, although some seedlings continue to emerge until fall (Klemow and Raynal 1981). Martin (1945 in Turkington et al. 1978) reported that temperatures of less than 15 degrees Centigrade are optimal for germination of *M. alba*, and germination inhibition occurs above 15 degrees Centigrade so seeds become less likely to germinate during the summer. A high percentage of seeds remain hard and contribute to the development of a large seed bank. These seeds will remain dormant until conditions are optimal for scarification, so abundance can fluctuate wildly from year to year.

Plant development and survivorship depend on temperature, rainfall during the first year of growth, site conditions, and date of emergence. Klemow and Raynal (1981) found survival of *M. alba* to be linear over the first year when conditions were cool and moist, with 3% of the population surviving to reproduce. When first year conditions were hot and dry, more plants died soon after germination and less than 1% survived to reproduce. Survival and development were better in a dense than in a sparse population in hot, dry years.

Sweetclover has been cultivated as a forage crop and soil builder throughout the United States since the early 1900's. It has been used most extensively in the north central and Great Plains states of North Dakota, Minnesota, Montana, Iowa and Wisconsin (Martin and Leonard 1949).

It is a threat to recovering prairies because it easily invades open areas and may compete for resources with native species or indirectly affect the prairie community by altering edaphic conditions (see below). It is aesthetically unpleasant on prairie preserves because it is a highly visible exotic when in flower. It is considered desirable in some areas of North and South Dakota and other states because it provides good wildlife cover.

Monitoring is necessary to track the success of management procedures. Patches should be monitored several weeks after prescribed burns to locate and hand-pull, if possible, plants that escaped the fire.

Sweetclover is most easily identified when in flower. Seedlings are easily confused with *Medicago* or *Trifolium* (see Description). Unburned patches of second year plants in flower may be possible to pick out in an aerial photo taken several weeks after a burn (Johnson 1987).

There are many questions for research that would be beneficial to management of sweetclover. These include: Does sweetclover have a direct ecological impact on native prairie species? Does it have an indirect effect, for example, does it attract pocket gophers to the area, or does it alter edaphic conditions to favor cool season exotics, perhaps by enriching soil nitrogen? In general, what are the effects of a big sweetclover year on the habitat and other plants? What are the optimal conditions for scarification of "hard" seeds that trigger germination and high survivorship of first-year plants some years? How effective is grazing and what animals avoid or prefer sweetclover over other species? In what ways do *M. alba* and *M. officinalis* respond differently to similar treatment?

Sweetclover is part of an invasive community of exotics which require special management to restrict growth and encourage the reestablishment and recovery of the native prairie community.

Sweetclover response to fire is variable depending on the time and frequency of burning, so prescribed burns in a sweetclover area must be carefully timed to achieve the desired response. In Minnesota and Wisconsin, spring burning from April through mid-May results in increased germination and development of first-year plants (Heitlinger 1975, Kline 1984). The common prairie management practice of conducting spring burns every few years can result in heavy sweetclover infestations (Kline 1984). Late fall dormant season burns also stimulate germination the following spring.

The best burn schedule for control of sweetclover in an even-age stand (or nearly so) appears to be a dormant season burn (late fall or early spring) to stimulate germination in the subsequent growing season, followed by a later spring burn the next season to eliminate the second year plants before they set seed (Kline 1984). The optimal time for the second year burn will vary with year and latitude, so managers should watch for the presence of elongating shoots. If the plants are burned before the shoots elongate, the meristematic buds will be close to the ground and may escape fire injury. If the first year is hot enough over the entire area, close to 100% germination of the seed bank can be achieved. New seed production can then be prevented if a follow-up burn is conducted before the plants set seed in their second year (Kline 1987). Kline (1984) reported the virtual elimination of sweetclover from experimental plots after conducting this two year burn schedule twice over six years in an even age stand (years three and four having no burns). No advantage was conferred by burning six years in succession (Kline 1984).

Problems may arise when the first year burn is incomplete or patchy leaving areas of ungerminated seeds, if conditions preclude burning either after emergence or before seed set of second-year plants, or if the stand is mixed first and second-year plants. In some situations (high moisture, low fuel) it is difficult to achieve a good, hot fire in the spring, and a late fall dormant season burn may be more effective at promoting germination of a high percent of the sweetclover seed bank (Johnson 1987). If weather conditions preclude burning the second generation plants, one approach is application of a herbicide such as 2,4-D, which kills the plants and prevents seed production. Schwegman and McClain (1985) stated that a fall burn followed by early spring seedling treatment with 2,4-D was an effective control measure of sweetclover. Since the sweetclover seedlings emerge before many prairie plants, they may be sprayed before other dicots are present (Schwegman and McClain 1985).

Another alternative to conducting a second year spring follow-up burn is to mow the first year plants in mid-to-late August, leave the cut tops to dry in the field for several weeks and then burn again in mid- to-late September (Heitlinger 1987). Heitlinger (1975) stated that first year sweetclover enters a "critical growth period" about the first of September, when root weight begins to increase rapidly as food is translocated from the tops for storage overwinter. Cutting or burning alone before this critical period may leave room for a substantial number of plants to resprout tops and store enough food to survive the winter. Cutting followed by burning would provide further assurance that plants would not survive, and allowing the cut tops to dry for several weeks should also provide fuel for an effective burn.

Follow-up burns to kill second-year plants may present conflicts with other objectives or financial constraints. In some areas, such as Minnesota, burning after mid-May is strongly discouraged due to the adverse effect on nesting birds and the consequent strong negative reaction from the public. The logistics of burning a large number of prairies in Minnesota calls for beginning prescribed burns in April, and consequently, second year sweetclover is left uncontrolled on many preserves (Johnson 1987). Johnson (1987) suggested that sweetclover may be more of an aesthetic than an ecological problem on prairie preserves, and as such it is a low priority for management, and herbicide treatment is not considered justifiable. If sweetclover control is determined to be a priority in an area, delaying burning to early or mid-May for one or two years in succession after a fall or April dormant season burn should effect a significant reduction in

abundance of flowering plants and the size of the seed bank, while still being early enough to allow for birds reneesting (Johnson 1987).

In an uneven-aged stand, a dormant season burn will stimulate seed germination, but will not affect the second-year plants that will subsequently resprout and set seed that summer. The later spring burn to kill second-year plants the next season may stimulate germination of the seeds set the previous year as well. Heitlinger (1987) recommended later spring burns, after shoots emerge but before second-year plants set seed, three to five years in succession, if possible, for control of uneven-aged stands. Kline (1987) and Martin (1987) noted that in slightly uneven-aged stands, burns prescribed to control the most abundant age group can be followed up with hand-pulling of the less abundant age group, before seed set for second-year plants.

Heitlinger (1975) and Martin (1987) noted that it is often good management practice not to burn an entire prairie in one season. This is especially true for areas where hand-pulling of sweetclover is necessary, such as in small patches or after spotty second year prescribed burns. If a large tract of prairie is burned all at once, sweetclover, as well as other exotics, can all come up again at once and be very difficult to control, either by hand-pulling or by a follow-up burn, before flowering takes place (Martin 1987). Splitting a large area into smaller tracts for staggered burns also minimizes the potential for adverse effects on non-target plants and animals. Optimal management of other exotic plant species may also call for prescribing burns at different times during the season. For example, a spring dormant season burn may not be practical if control of cool season grasses, such as *Poa pratensis*, is a priority in an area. Late spring/early summer burns, effecting a decline in many cool season exotics while stimulating growth of warm season natives, will also reduce abundance of first- and second-year sweetclover. A good plan is to burn adjacent plots in different years and at different times during the season (Heitlinger 1975).

Very small (one to several acre) preserves can also present a problem for sweetclover management. Hanson (1987) stated that frequent burning (i.e., annually for two or more years in succession) is not a good practice for very small prairies because grasses tend to proliferate at the expense of desirable forbs. On a small cemetery prairie near Urbana, Illinois, burns are conducted in the spring about once every four years, which is ideal for sweetclover germination and survivorship. Since the prairie is small, hand-pulling is feasible. Hand-pulling of first year stems is recommended in late summer/early fall when the sweetclover is still green and easily detected among the dried grasses (Hanson 1987). Clipping may also take the place of follow-up burns, is easier and will cause less disruption of the soil microenvironment than hand-pulling. If plants are clipped close to the ground below the lowest branch axils, no resprouting will occur, although this may be difficult in practice (Heitlinger 1975). Ladd (1987) reported that on a loess hill prairie in northwest Missouri approximately 30% of second year plants hand clipped as low to the ground as possible had resprouted.

Sweetclover can be especially troublesome in areas not under management for prescribed burns. On some state lands in North Dakota where this situation exists, management procedure has been to mow in late spring/early summer. This generally reduces but does not prevent seed set, as flowering shoots can resprout from axils below the mow height (Horner 1987). A power brush cutter can be used to cut the plants close to the ground before flowering.

Little information is available on grazing effects on sweetclover, but observations at the Ordway Prairie in South Dakota suggest that bison tend to avoid it while cattle consume it quite readily (Heitlinger 1987). Kruz (1987) recommended a May burn followed by grazing in September-October, but a high stocking rate is required.

Thick, almost monospecific stands can be difficult to burn due to the low fuel content of sweetclover, and their size may preclude hand-pulling or mowing. If left alone, the plants will die after flowering and density will probably decline in subsequent years as conditions for germination change (Heitlinger 1975, Plumb 1987).

Minnesota: There are several preserves where burns are prescribed to effect a decline in sweetclover abundance. Since burning is often conducted when sweetclover is still dormant in April, it is left unmanaged at many preserves and is not considered a management priority. An early spring burn in 1986 followed by a May burn in 1987 has

significantly reduced sweetclover abundance on Schaefer Prairie. Contact: The Nature Conservancy, Minnesota Field Office, 1313 5th St. S.E., Minneapolis, MN 55414. (612) 379-2134.

South Dakota: Aurora Prairie had abundant sweetclover on one 10-acre tract in the early 1980's. This area was burned in late April of 1981, '82, '83, and '84, and in mid-May in 1987. Management plans are to burn again in May of 1988 and '89 before letting the site rest unburned for three years (the other 17 acre tract on this prairie will be burned during this time). Sweetclover abundance has declined dramatically, although some plants can still be found.

Wisconsin: Sweetclover is a management concern on many Nature Conservancy and state lands. Control is accomplished by several methods. Martin (1987) and Kline (1987) recommend burning in early April first year, burning in mid-May and/or hand-pulling early in the second year of growth. Ahrenhoerster (1987) has conducted management by cutting right at ground level when plants are in full bloom or burning in early spring and then mowing close to the ground when seedlings are 6-8 inches tall.

Illinois: Sweetclover is considered a serious management problem by the Dept. of Conservation in Illinois. On state lands fall burning is prescribed for prairie management in general, and sweetclover is then sprayed with 2,4-D in early spring when seedlings are very small, before other prairie dicots are up. Contact: Illinois Dept. of Conservation, Natural Heritage Division, 524 S. 2nd St., Springfield, IL 62701. (217) 785-8688.

Elisabeth Hanson manages two small (less than one acre) cemetery preserves near Urbana where sweetclover is a problem. Management procedure has been to hand-pull first-year plants at the end of their first year.

Iowa: On Nature Conservancy land, Sioux City Prairie has significant sweetclover patches, mainly in valleys that were most intensively grazed in the past. Late spring burns (mid- to late-May) are conducted when the sweetclover is in a good growth phase. Hand-pulling is also conducted in spring and summer before second-year plants go to seed. Contact: Iowa Field Office, The Nature Conservancy, 424 10th St. Suite 311, Des Moines, IA 50309. (515) 244-5044.

Even-aged stands of sweetclover can be effectively controlled in areas subjected to prescribed burns by conducting a dormant season burn in late fall or early spring one year to promote germination, followed by a later spring burn in May the next growing season before second-year plants set seed. Uneven-aged stands may require three-to-five years of May or June burns in succession to adequately control seed production. Monitoring should be conducted to track the success of the burns because incomplete or cool fires will leave patches of ungerminated seed or incompletely burned plants. Small patches may be hand-pulled or machine cut below the lowest axil before they set seed. Research should concentrate on defining germination requirements, determining the ecological impact of sweetclover on the prairie community, and developing effective control methods where prescribed burns and herbicides are impractical.

Literature cited:

- Ahrenhoerster, R. 1987. Prairie Seed Source, Northlake, WI. Telephone conversation with N. Eckardt, The Nature Conservancy, Midwest Regional Office. July 17, 1987.
- Barcikowski, B. 1966. Self-fertility and inbreeding depressions in white and yellow sweetclover (*Melilotus alba* Desr. and *M. officinalis* (L.) Desr. Genet. Pol. 7:1-11.
- Coe, H.S. 1917. Sweetclover: growing the crop. Farmer's Bulletin 797, USDA.
- Fernald, M.L. 1950. Gray's Manual of Botany. 8th Ed. American Book Co., N.Y. 1632 pp.
- Heitlinger, M. 1975. Burning a protected tallgrass prairie to suppress sweetclover, *Melilotus alba* Desr. Prairie: A Multiple View, M.K. Wali, ed. Univ. of N.D. Press. pp. 123-132.
- Klemow, K.M. and D.J. Raynal. 1981. Population ecology of *Melilotus alba* in a limestone quarry. J. Ecol. 69:33-44.
- Kline, V.M. 1984. Response of sweetclover (*Melilotus alba* Desr.) and associated prairie vegetation to seven experimental burning and mowing treatments. Proc. 9th N.A. Prairie Conf. pp. 149-152.

- Martin, J.H. and W.H. Leonard. 1949. Sweetclover. Principles of Field Crop Production. Macmillan Press, New York. pp. 685-699.
- Rydberg, P.A. 1971. Flora of the prairies and plains of central North America. Dover Publications, New York. 503 pp., 2 vol.
- Schwegman, J.E. and W.E. McClain. 1985. Vegetative effects and management implications of a fall prescribed burn on an Illinois prairie. Nat. Areas Journal 5(3):4-8.
- Stevenson, G.A. 1969. An agronomic and taxonomic review of the genus *Melilotus* Mill. Can. J. plant Sci. 49:1-20.
- Turkington, R.A., P.B. Cavers, and E. Empel. 1978. the biology of Canadian weeds. 29. *Melilotus alba* Desr. and *M. officinalis* (L.) Lam. Can. J. Pl. Sci. 58:523-537.

Other Citations:

- Kline, V.M. 1987. Ecologist. Univ. of Wisconsin Arboretum. Telephone conversation with N. Eckardt, The Nature Conservancy, Midwest Regional Office. June 26, 1987.
- Johnson, R. 1987. Director of Stewardship, The Nature Conservancy, Minnesota Field Office. Personal communication with N. Eckardt, The Nature Conservancy, Midwest Regional Office. July 9, 1987.
- Kruz, A. 1987. U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, ND. Telephone conversation with N. Eckardt, The Nature Conservancy, Midwest Regional Office. June 29, 1987.
- Hanson, E. 1987. Volunteer Manager, Tomlinson Pioneer Cemetery Prairie Nature Preserve, Urbana, IL. Telephone conversation with N. Eckardt, The Nature Conservancy, Midwest Regional Office. July 17, 1987.
- Heitlinger, M. 1987. Midwest Region Director of Stewardship. Personal communication with N. Eckardt, The Nature Conservancy, Midwest Regional Office. July 14, 1987.
- Horner, D. 1987. U.S. Park Service, Bismarck, ND 58501. Personal communication with N. Eckardt, The Nature Conservancy, Midwest Regional Office. July 1987.
- Martin, M. 1987. Wisc. Dept. of Natural Resources. Telephone conversation with N. Eckardt, The Nature Conservancy, Midwest Regional Office. June 29, 1987.
- Plumb, G. 1987. Research and Management Associate, Ordway Prairie Preserve, SD. Telephone conversation with N. Eckardt, The Nature Conservancy, Midwest Regional Office. June 25, 1987.

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